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A Disaggregated and Macro-consistent Social Accounting Matrix for Pakistan

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Abstract This paper provides future researchers of economic structure with a model for building a social accounting matrix (SAM), that is, a unique countrywide database for use in structural analysis, and applies this model to the empirical investigation of the economic structure of Pakistan. Our proposed approach to building SAMs is motivated by an information theoretic approach to estimation that takes a Bayesian view of the efficient use of information: "Use all the information you have, but do not assume any information you do not have." The methodology used to develop this SAM, unlike previous approaches, ensures that it is perfectly consistent with the national accounts. The SAM provides a high degree of detail on the economic structure of the country, with 51 sectors of activity, 27 factors of production, and 18 household groups, allowing the tracing of direct and indirect effects of potential scenarios through production and consumption linkages and the capture of distributional effects. Output multipliers in Pakistan, accounting for supply constraints, range from 1.1 to 1.4, and shocks to livestock and industry have the largest spillover effects. These shocks lead to income changes that differ significantly across domestic socioeconomic groups, a direct result of the heterogeneity in the generation of income of these groups that our countrywide database captures.

Keywords Social accounting matrix (SAM) · Multiplier analysis · Pakistan · Economic structure

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1 Introduction

A social accounting matrix (SAM) is an internally consistent single-entry accounting system that documents all the economic transactions within an economy. SAMs support the continuing need to use recent and consistent multisectoral economic data for policy analysis and the development of economy wide models (Robinson et al. 2001). A SAM is an extended set of national accounts that disaggregates the value added in each production activity into payments to various factors such as land, labor, and capital, and disaggregates household incomes and expenditures according to various household types. Mathematically, a SAM is a square matrix in which each account is represented by a row and a column. Each cell shows the payment from the account of its column to the account of its row. Thus, the incomes of an account appear along its row and its expenditures along its column. The underlying principle of double-entry accounting requires that, for each account in the SAM, total revenue (row total) equals total expenditure (column total).

Data typically used to build SAMs include an input–output (IO) matrix of the economy, national accounts, fiscal accounts, trade data, other balance-of-payments information, and surveys providing information on the composition of household income and expenditures. Given its ability to capture interindustry linkages and household income and expenditure composition while being consistent with macroeconomic accounts, a SAM can serve as a unique economic database for structural analysis. However, in order for academics to be able to fruitfully employ a SAM to perform up-to-date structural analysis, the SAM needs to provide rich and current detail on the income and expenditure patterns of the production sectors, production factors, and households of an economy: only a SAM with a rich disaggregation of accounts allows the heterogeneity of the income and expenditure composition among households to be reflected in a significant way and, as a result, allows the distributional effects of changes in the composition of output in the economy to be identified.

This paper provides a model for future researchers looking to build a SAM and applies the model to Pakistan, creating a highly disaggregated and updated SAM. This SAM is then used to describe the structure of the Pakistani economy through multiplier analysis in an attempt to provide a useful reference and resource for academics concerned with the structure of Pakistan's economy.

The Pakistani economy has undergone marked changes during the last decade, which call for an updated countrywide database. In only 10 years, the share of the country's service sector increased from 50.7 % (2000) to 54.6 % (2010); the share of the textile sector in total exports decreased from 64.8 % (2000) to 53.0 % (2010); and the labor force grew significantly, due not so much to the annual population growth rate of around 2 %, but more to an impressive increase in the labor participation rate, which though still low by international standards, grew from 28.9 % (2000) to 45.7 % (2010) (State Bank of Pakistan 2010).

Our paper is organized as follows. In Sect. 2, we review past SAMs for Pakistan and highlight their relative strengths and weaknesses in capturing sector, factor, and

Table 1 Previous SAMs for Pakistan

No.	Name of researchers or organization	Salient features
1	Pakistan Institute of Development Economics (1985)	*Base year*: 1979
2	Federal Bureau of Statistics (1993)	*Base year*: 1984/1985 *Households*: 1
3	Siddiqui and Iqbal (1999)	*Base year*: 1989/1990 *Sectors (5)*: agriculture, industry, education, health, other sectors *Factors (2)*: labor and capital *Agents*: households (8), firms, government, rest of the world
4	Dorosh et al. (2004) (DNN)	*Base year*: 2001/2002 *Sectors (34)*: agriculture (12), industry (16), services (6) *Factors*: 27 *Agents*: households (19), enterprises, government, rest of the world
5	Waheed and Ezaki (2008)	*Base year*: 1999/2000 *Sectors (6)*: agriculture; mining and quarrying; manufacturing; electricity, water, and gas; construction; other sectors *Factors (2)*: labor and capital *Agents*: households (1), firms, government, commercial banks, central bank, rest of the world

We were unable to obtain access to SAMs Nos. 1 and 2. Source: Authors' literature review

household detail. In Sect. 3, we explain our approach to building a SAM and how we apply the model to Pakistan. Based on the resulting SAM, in Sect. 4 we analyze the structure of the Pakistani economy, and in Sect. 5 we conduct income multiplier analysis to further illuminate the economic structure of the country. Section 6 concludes.

2 Previous Social Accounting Matrixes for Pakistan

A limited number of SAMs have been constructed for Pakistan (Table 1). The first represented the Pakistani economy in the year 1979 and was constructed in 1985 by the Pakistan Institute of Development Economics. It was followed by a SAM for the year 1984/1985, created by the Federal Bureau of Statistics (FBS) with collaboration from the Dutch government under the Improvement of National Accounting System project. Because this SAM had a single household group, it was not suitable for analyzing distributional effects across households.

Siddiqui and Iqbal (1999) developed another SAM for 1989/1990, aggregating the IO matrix industry classifications into five activity accounts and disaggregating household income and expenditures into eight household groups, allowing for distributional analysis among households. In 2004, Dorosh et al. (2004) (DNN henceforth)

produced an additional SAM of Pakistan for the year 2001/2002, which even when relying on the same IO matrix as Siddiqui and Iqbal, allowed for much larger disaggregation, containing 19 household groups and 34 production sectors. The suitability for analyzing the effects of shocks in specific industries on different socioeconomic groups improved significantly with this SAM, as households were disaggregated by province (Sindh, Pakistan, and rest of Pakistan) and the number of commodities was larger than in Siddiqui and Iqbal (1999). The DNN SAM is at present informing the Global Trade and Analysis Project SAM for Pakistan, which has five factors and 57 sectors but a single representative household and is therefore not suitable for distributional analysis among household groups. More recently, and relying on the same IO matrix (still the most recent matrix available for the country), Waheed and Ezaki (2008) provided a bridge between the real and the financial sides of the Pakistani economy, reflecting the growing importance of capital flows and the availability of the associated data, by creating a real/financial SAM for the year 1999/2000. However, in this case, production sectors were aggregated into only six accounts, with no disaggregation into different household groups.

3 Methodology for Developing the SAM

In designing the accounts for our SAM, we take as a base the accounts of the SAM developed by DNN, as it is the most disaggregated one created thus far for the country. Starting from this base, we further increase the disaggregation of the SAM accounts and use more updated information in many spheres. While the textile industry was aggregated into a single account in DNN, we disaggregate it into knitwear, garments, and other textiles—all relevant textile activities in Pakistan. We disaggregate cotton into ginning, spinning, and weaving, and chemicals into fertilizers and other chemicals. Reflecting the growth of the service sector in the country, we substantially disaggregate this sector: trade (a single account in DNN) is split into wholesale, retail, and other trade; transport into road, rail, air, water, and other transport; housing into rented and owned; and other private-sector services into education, healthcare, business services, personal services, and other private services. As in DNN, households are disaggregated according to province, among other criteria. Out of the 18 household groups, 12 represent agricultural households. Agricultural households are classified by farm ownership and size (small vs. medium/large),[1] enabling an in-depth analysis of the distributional effects of changes in the agricultural sector and its linkages with other industries. Nonagricultural households are classified as urban or rural. While in DNN these groups are disaggregated into two subgroups (poorest 20 % and rest), we disaggregate them into three subgroups according to per capita expenditure: quintile 1, quintile 2, and rest.

Our proposed approach to developing SAMs is motivated by an information theoretic approach to estimation (Judge and Mittelhammer 2012) that takes a Bayesian view of the efficient use of information: “Use all the information you have, but do not

[1]Medium/large farm households are defined as those owning 12.5 acres or more of land. Small farm households are those owning less than 12.5 acres of land.

assume any information you do not have." Previous work on SAM estimation using this approach includes Judge and Mittelhammer (2012), Golan et al. (1994, 1996), Robinson et al. (2001), Debowicz (2010), and Zellner (2004).

In this spirit, we have designed a series of major steps that we list in Fig. 1 that lead to an estimated macro-consistent and disaggregated SAM for a countrywide economy. The steps, which are explained in detail below, start from a schematic SAM (Table 2) and, using a variety of data sources and balancing the accounts of the SAM with the use of a cross-entropy technique, lead to a macro-consistent and disaggregated SAM. In particular, after constructing an aggregated SAM based on macro figures, parsimonious disaggregation of the accounts allows the researcher estimating the SAM to keep sight of the role that different types of information play. Right after each disaggregation, the accounts of the SAM are balanced, using information from local experts on which values are to be trusted in the case of major imbalances, and with the use of a cross-entropy technique that allows to perfectly balance the accounts while keeping the information on the SAM consistent with macro figures publicly available for the country.

Table 3 shows the numerical macro-SAM that we obtain in domestic currency for Pakistan after step 2, and Table 4 shows the data sources that need to be used in order to estimate it.

3.1 Construction of the First Imbalanced Proto-SAM

After estimating an aggregated SAM, the next step is to split the domestic value added into multiple sectors (51 sectors in the case at hand, as listed in the SAM accounts in Fig. 2). In doing this, we start from the value added by each major sector (2007/2008 gross national product at current factor cost), which sums to the value added in the macro-SAM, and split the sectors as follows:

1. Major and minor crops are disaggregated into wheat, rice, cotton, sugarcane, fruits and vegetables, and other field crops using the 2007/2008 data from *Agricultural statistics of Pakistan*, "Gross Value Addition of Major Crops at Current Factor Cost" and "Gross Value Addition of Minor Crops at Current Factor Cost" (Pakistan, Ministry of Food and Agriculture 2009).
2. Rice and wheat are further split using production of rice varieties and irrigated and nonirrigated wheat from *Agricultural statistics of Pakistan*.
3. Livestock is split into poultry and other livestock using the value of their output as identified by *Agricultural statistics of Pakistan*.
4. Manufacturing is split into vegetable oil, wheat milling, IRRI rice milling, basmati rice milling, refinement of sugar, other food, lint, yarn, cloth, knitwear, garments, other textiles, leather, wood, fertilizer, other chemicals, cement, petroleum refining, and other manufacturing using the most recent available Census of manufacturing industries (CMI) (FBS 2006).
5. Trade is split into wholesale, retail, and other using the *Study on wholesale and retail trade, hotels and restaurants in Pakistan* (FBS 2002).
6. Transport is split into road, rail, water, air, and other, such as transport by tubes, using *National accounts of Pakistan: rebasing from 1980–81 to 1999–2000* (FBS 2004).

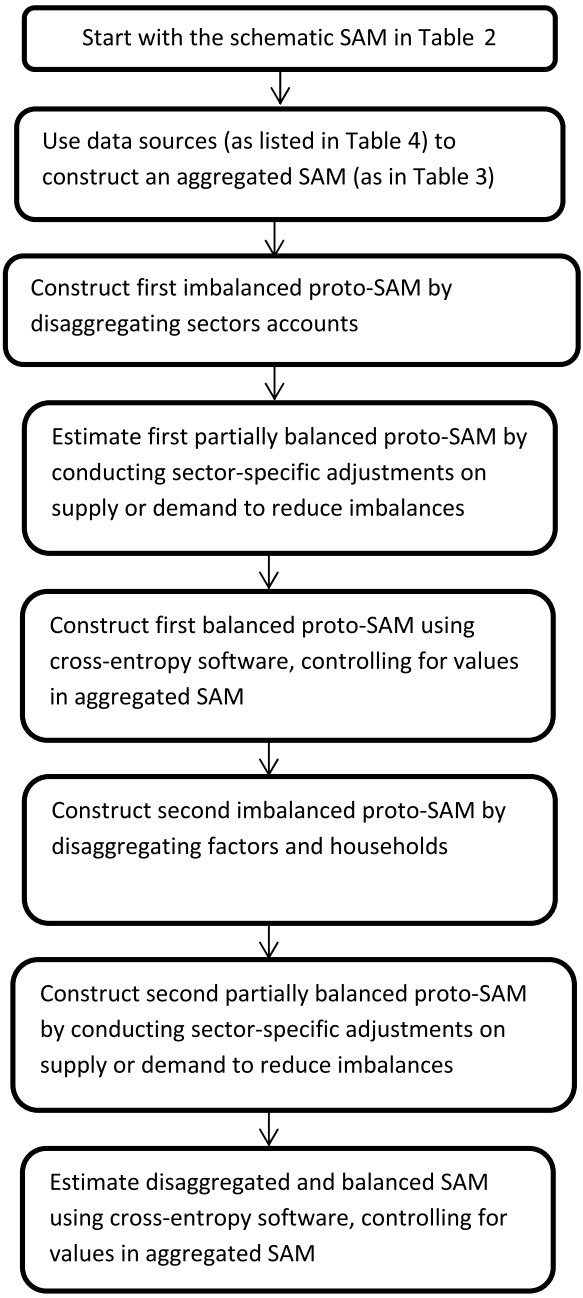

Fig. 1 Suggested steps to build a SAM

7. Housing is split into owned and non-owned using data from the Survey on community and personal services (FBS 2001).
8. "Social, community, and personal" services are split into business, education, health, personal, and other services using the same source.

Table 2 A generic schematic SAM

	Activities	Commodities	Land	Labor	Capital	Households	Government	Change in stocks	Savings: investment	Rest of the world
Activities		Supply matrix								
Commodities	Intermediate consumption					Final private consumption	Final public consumption	Change in stocks	Fixed investment	Exports
Land	Value added by land									
Labor	Value added by labor									
Capital	Value added by capital									
Households			Payment from land to households	Payment from labor to households	Payment from capital to households		Transfers from government to households			Remittance to households
Government		Sales and imports tax			Payment from capital to public sector	Direct taxes				Transfers from nonresidents to government
Change in stocks									Change in stocks	
Savings: investment						Household savings	Government savings			Foreign savings
Rest of the world		Imports			Repatriation of dividends and utilities		Government payments to nonresidents			

Source: Based on Robinson et al. (2001)

Table 3 Macro-SAM for Pakistan 2007/2008 (in billions of Pakistani rupees)

	Activities	Commodities	Land	Labor	Capital	Households	Government	Sales tax	Import tax	Direct tax	Stocks	Savings: investment	Rest of the world	Total
Activities		25,743												25,743
Commodities	15,822					8,046	1,278				164	2,095	1,502	28,907
Land	576													576
Labor	2,651													2,651
Capital	6,695													6,695
Households			576	2,651	5,998		617						763	10,605
Government					442			171	151	391			27	1,181
Sales tax		171												171
Import tax		151												151
Direct tax						391								391
Stocks												164		164
Savings: investment						2,168	−777						868	2,259
Rest of the world		2,842			254		63							3,160
Total	25,743	28,907	576	2,651	6,695	10,605	1,181	171	151	391	164	2,259	3,160	

Source: Pakistan National accounts and other data sources listed in Table 4

Table 4 Sources of data for macro-SAM

Macro-SAM item	Source
Value added by land	National accounts, gross national product at current factor cost 2007/2008 of agricultural sectors (PBS 2012) multiplied by share of land in value added of agricultural sectors from Dorosh et al. (2004)
Value added by labor	National accounts, gross national product at current factor cost 2007/2008 for each sector (PBS 2012) multiplied by share of labor in value added of sector in IO matrix (FBS 1991)
Value added by capital	National accounts, gross national product at current factor cost 2007/2008 (PBS 2012) minus two above
Intermediate consumption	National accounts, gross national product at current factor cost 2007/2008 for each sector (PBS 2012) multiplied by ratio of intermediate consumption and value added in those activities in IO matrix (FBS 1991)[a]
Supply matrix	Sum of payments above
Direct tax	Pakistan, Ministry of Finance (2009), "Fiscal Development" item "Direct Taxes" 2007/2008
Import tax	Pakistan, Ministry of Finance (2009), Pakistan: Summary of Consolidated Federal and Provincial Revenue 2007–2008, Taxes on International Trade
Sales tax	Table 1.4 in State Bank of Pakistan (2010), Indirect Taxes − Subsidies − Import Tax
Final public consumption	Table 1.4 in State Bank of Pakistan (2010), General Government Consumption Expenditure FY08
Change in stocks	Table 1.4 in State Bank of Pakistan (2010), Changes in Stocks FY08
Fixed investment	Table 1.4 in State Bank of Pakistan (2010), Gross Domestic Fixed Capital Formation FY08
Exports	Table 2 in IMF (2010), Pakistan: Balance of Payments, 2007–2008. "Exports: FOB" + "Services: Credit"
Imports	Table 2 in IMF (2010), Pakistan: Balance of Payments, 2007–2008. "Imports: FOB" + "Services: Debit"
Final private consumption	Residual of commodity account
Payment from land to households	Value added by land
Payment from labor to households	Value added by labor
Repatriation of dividends and utilities	Table 2 in IMF (2010), Pakistan: Balance of Payments 2007–2008. "Income: Debit" + "Current Transfers: Debit" − "Income: Credit"
Payment from capital to public sector	Table 3.7 in State Bank of Pakistan (2010), Residual of Public Incomes

We subsequently split the value added of each of these sectors into a payment to land, a payment to capital, and a payment to labor. For crops, we use the factor shares at the activity level in the cost of production of Pakistan (2003) as informed by the Agriculture Policy Institute (Agricultural Prices Commission 2003). For the

Table 4 (*Continued*)

Macro-SAM item	Source
Government savings	Pakistan, Ministry of Finance (2009), Pakistan: Summary of Consolidated Federal and Provincial Budgetary Operations, Provisional, Table 1, Budget Deficit 2007–2008
Government payments to nonresidents	Table 3a in IMF (2010), Share of Foreign into Total Payment of Interest by GOP 2008–2009 (not available for 2007–2008) multiplied by Table 3.7 in State Bank of Pakistan (2010), Interest Payment FY08 Consolidated Federal and Provincial Governments
Transfer from nonresidents to government	Table 7.2 in State Bank of Pakistan (2010), Net Current Transfers of General Government in Balance of Payments FY08
Transfer from government to households	Residual in government account

[a]The classification of activities in the IO matrix (IO91) is presented in the Appendix

remaining activities, where land does not add value, the shares of labor and capital are identified by the most updated IO matrix (FBS 1991) and the sectors in the IO matrix are mapped to those in the SAM using Table 5. Then we split the intermediate use of each activity among commodities using recent information on the production costs of crops (Agricultural Prices Commission 2009) and the IO matrix.

The supply of each activity sector is allocated to its corresponding commodity.[2] The sector composition of private final consumption is informed by expenditures present in the Household Income and Expenditure Survey (HIES) (FBS 2008), expanded with the sample household weights, and using Table 6. The sector composition of fixed investment, changes in stocks, and public final consumption is informed by the IO matrix and the respective mapping into SAM accounts (Table 5). The sector composition of imports and exports is informed mainly by 2007/2008 trade data from the Pakistan Economic Survey (Pakistan, Ministry of Finance 2009), and 2008 import data from the Pakistani Ministry of Commerce (Pakistan, Ministry of Commerce 2011) and United Nations Conference on Trade and Development (UNCTAD 2008). Commodity-specific import revenue is estimated by multiplying the value of imports of each commodity and the associated tariff rates available for Pakistan from the Federal Board of Revenue (FBR 2008). The sales tax is split among commodities in proportion to the already calculated production value of each commodity.

3.2 Balancing the First Proto-SAM

At this stage, relatively large imbalances are found in lint, mining, construction, and business services. Relying on supply information provided by CMI and consultation

[2]Given data availability, secondary production is ignored. A slight modification in the procedure would be needed if data on secondary production were available.

Activities (51)
Agriculture (12): Wheat irrigated, wheat nonirrigated, rice—IRRI (irrigated), rice—basmati (irrigated), cotton (irrigated), sugarcane (irrigated), other field crops, fruits/vegetables, livestock (cattle, milk), livestock (poultry), forestry, fishing
Industry (22): Mining, vegetable oils, wheat milling, rice milling (IRRI), rice milling (basmati), sugar, other food, cotton gin (lint), cotton spin (yarn), cotton weave (cloth), knitwear, garments, other textiles, leather, wood, chemicals, fertilizers, cement and bricks, petroleum refining, other manufacturing, energy, construction
Services (17): Trade—wholesale, trade—retail, trade—other, transport—rail, transport—road, transport—water, transport—air, transport—other, housing, imputed rent, business services, healthcare, education, personal services, other private services, public services, finance and insurance

Commodities (50)
Same as activities, except wheat irrigated and wheat nonirrigated activities aggregated as one commodity (wheat)

Factors (27)
Labor (10): Own-farm (large farm, medium farm Sindh, medium farm Punjab, medium farm other Pakistan, small farm Sindh, small farm Punjab, small farm other Pakistan), agricultural waged, nonagricultural unskilled, nonagricultural skilled
Land (12): Large farm (Sindh, Punjab, other Pakistan), irrigated medium farm (Sindh, Punjab, other Pakistan), irrigated small farm (Sindh, Punjab, other Pakistan), nonirrigated small farm (Sindh, Punjab, other Pakistan)
Other factors (5): Water, capital livestock, capital other—agriculture, capital formal, capital informal

Households (18)
Rural (15): Large/medium farm (Sindh, Punjab, other Pakistan), small farm (Sindh, Punjab, other Pakistan), landless unwaged farmer (Sindh, Punjab, other Pakistan), landless waged farmer (Sindh, Punjab, other Pakistan), rural nonfarm per capita expenditure quintile 1, quintile 2, and rest
Urban (3): Per capita expenditure quintile 1, quintile 2, and rest

Other Institutional Accounts (4)
Government (including separate subaccounts for import taxes, direct taxes, and sales taxes), rest of world, savings—investment, change in stocks

Fig. 2 Accounts in the SAM

with local experts, we perform a series of adjustments mostly on the final consumption and investment of the commodities that reduce the imbalances at the commodity level to less than 30 % of the average between supply and use. We then balance this proto-SAM, seeking to minimize the cross-entropy distance between the first partially imbalanced and balanced proto-SAMs, imposing the series of controls present in the macro-SAM. Following the approach described in Golan et al. (1994), we treat every cell in the proto-SAM as being specified with an error support set whose weights are estimated to minimize the cross-entropy distance between the prior and the solution proto-SAM. This treatment is strongly related to the one described in Robinson et al. (2001), with key differences. In the previous approach, the column coefficients in the SAM were treated analogously to probabilities and included directly in the cross-entropy minimand, creating the need for special treatment of negative cells and accounts with zero sums in the SAM. In the approach we apply, developed by Sherman Robinson and Scott McDonald—starting from Robinson et al. (2001)—the cross-entropy minimand includes only probability weights for a selected error support set, such that the SAM coefficients are no longer treated as analogous to probabilities, and

Table 5 Mapping of the sectors in the input–output matrix (IO91) to those in the SAM

Sectors in IO91	*SAM 2007/2008 Sectors*	*Sectors in IO91*	*SAM 2007/2008 Sectors*
2	Wheat (irrigated)	37	Wood
2	Wheat (nonirrigated)	39, 41, 44	Chemicals
1	Rice (IRRI)	40	Fertilizers
1	Rice (basmati)	45, 46	Cement and bricks
3	Cotton	42	Petroleum refining
4	Sugarcane	38, 43, 47–57	Other manufacturing
6, 7, 11, 12	Other field crops	58, 59	Energy
8, 9, 10	Fruits and vegetables	60	Construction
13	Livestock (cattle, milk)	61	Wholesale trade
13	Livestock (poultry)	62	Retail trade
14	Forestry	63	Other trade
15	Fishing	64, 69	Railway transport
16, 17, 18	Mining	65	Road transport
19	Vegetable oils	66	Water transport
20	Wheat milling	67	Air transport
20	Rice milling (IRRI)	68	Other transport
20	Rice milling (basmati)	75	Housing
22	Sugar	76	Imputed rent
5, 21, 23, 24, 25	Other food	77	Business services
26	Cotton gin (lint)	80	Healthcare
27	Cotton spin (yarn)	79	Education
28	Cotton weave (cloth)	82	Personal services
31	Knitwear	81	Other private services
32, 33, 34	Garments	70, 78	Public services
29, 30	Other textiles	71, 72, 74	Finance and insurance
35, 36	Leather		

negative entries and accounts with zero sums do not require any special treatment.[3] The present approach allows specification of a prior estimate of the mean and standard error of selected cell entries (expressed either as values or column coefficients), column sums, and macro aggregates. These errors can be specified as additive or multiplicative-exponential. For the aggregates present in the Pakistan macro-SAM, we set a zero standard error. This, unlike previous approaches, allows us to arrive at a SAM that is perfectly consistent with the macro-SAM, such that the sum of the value added in the solution SAM is exactly equal to the gross national product at factor cost in the macro-SAM; the private final consumption in the solution SAM sums exactly the private final consumption in the macro-SAM, and similarly for public consumption in goods and services, investment, total exports, and total imports.

[3]The associated GAMS (General Algebraic Modeling System) code is available from the authors upon request.

Table 6 Mapping the commodities in the Household Income and Expenditure Survey (HIES) to the sectors in the SAM

Commodities in HIES	*SAM 2007/2008 Commodities*
2103–2104, 2201–2206	Other field crops
1301–1308, 1501–1510	Fruits and vegetables
1101–1103, 1201–1202	Livestock (cattle, milk)
1203–1204	Livestock (poultry)
1205	Fish
2301–2303	Vegetable oils
2101, 2502, 2503	Wheat flour
Part of 2102	Rice (IRRI)
Part of 2102	Rice (basmati)
1701	Sugar
1803, 2105, 2501, 2504, 2601	Other food
6103	Cotton cloth
5103	Knitwear
5101–5102, 5104–5105	Garments
6102, 6104	Other textiles
5201–5202	Leather
2701	Wood
5601	Chemicals
4301	Petroleum
6101, 6302–6303, 6305, 6401, 6403–6404	Other manufacturing goods
2702–2707, 2709	Energy
2406	Construction
4303	Railway transport
4302, 4304, 6505	Road transport
5705	Air transport
5401–5402, 5405	Housing
5403–5404	Imputed rent
5602	Healthcare
5801–5804	Education
2901–2903	Personal services
4401, 5903–5904	Other private services

3.3 Disaggregating the Payments Related to Factors and Households

To fully disaggregate the incomes and payments of the single household group and the three factors (labor, capital, and land) of the first balanced proto-SAM into the complete set of factors and households of the SAM, we take the following steps. The value added of each activity is split among the (27) factors using the shares present in DNN, in turn partly informed by the Pakistan Rural Household Survey (PRHS) (Pakistan Institute of Development Economics 2001).

After this, regarding payments from factors to institutions, payments from capital to government and to nonresidents are taken directly from the macro-SAM and attributed to formal capital. The matrix of household incomes is split as follows. Household income from labor, agricultural capital, and nonagricultural formal capital is split among households following household incomes in HIES; livestock income is split following the value of the livestock capital stock owned by households in HIES; and land and water income is split among households following DNN.

Income from informal nonagricultural capital (which includes returns to self-employed labor in informal-sector activities) is split between rural and urban households, using as proxy the share of rural population in total population as informed by HIES (67 %). The further split across rural households uses reported incomes from nonfarm enterprises in a rural household survey (PRHS) and updated household population totals (HIES). The remaining (33 %) nonagricultural wage income is allocated between urban nonpoor and poor households following DNN.[4] In the absence of detailed and reliable information, returns to agricultural capital are split among households in proportion to their land income, and public transfers and remittances to households informed in the macro-SAM are allocated among households in proportion to their total expenditures.

Final private consumption of each commodity is split among the (18) household groups using HIES. We assume that the more disadvantaged households are able to save a lower share of their income. A relatively high (15 %) savings rate is used as a prior for medium/large farms and nonfarm households (quintiles 3 to 5), and a relatively low (7 %) savings rate is assumed for the remaining households except for the "other urban" households (quintiles 3 to 5), an account that also captures enterprise savings. For this last household category, the savings rate is determined residually from the domestic private savings figure in the macro-SAM (37.5 %).

3.4 Balancing the Final SAM

After a series of adjustments to the less reliable parts of the household accounts (informal capital household income and nonfood household expenditures) based on consultation with local experts to reduce the imbalances at the household level to less than 30 percent of the average between their total income and total expenditure, the cross-entropy balancing code is run, imposing once again the series of controls present in the macro-SAM. This is the last step in the estimation of a balanced, macro-consistent, and largely disaggregated SAM that captures the economic structure of the country in an updated way and with a significant degree of detail.

4 Structure of the Pakistani Economy: Observations from the SAM

The structure of value added (Table 7) is characteristic of a semi-industrialized economy with a relatively low share of agriculture (20 %) and large shares of industry and

[4]Estimates of earnings from informal enterprises are perhaps the most uncertain figures in the SAM. Income data from the PRHS 2001/2002 appear to seriously underreport these earnings for rural households. If per capita informal-sector earnings from the PRHS 2001/2002 are used as the basis for calculating total earnings in rural areas, the share of rural households in total informal-sector earnings is only 7.2 percent.

Table 7 Structure of the economy, 2007/2008

	Output (%)	Value added (%)	Export (%)	Import (%)	Export/output (%)	Import/domestic absorption (%)
Agricultural sector	12.1	20.3	1.6	3.0	0.9	2.9
Crops	5.7	8.9	0.8	2.8	0.9	5.7
Livestock	5.9	10.6	0.2	0.2	0.2	0.4
Fishing	0.4	0.5	0.7	–	12.5	–
Forestry	0.1	0.3	–	–	–	–
Industrial sector	47.3	26.8	67.2	76.2	9.2	17.8
Mining and quarrying	2.6	3.0	0.0	10.7	0.0	33.4
Manufacturing	38.9	19.7	67.2	65.5	11.2	18.8
Electricity, gas, and water distribution	1.2	1.5	–	–	–	–
Construction	4.6	2.6	–	–	–	–
Services sector	40.7	52.9	31.1	20.8	4.9	6.2
Wholesale and retail	10.3	18.4	0.1	0.6	0.1	0.7
Transport and communication	14.0	11.7	14.9	–	6.8	–
Ownership of dwellings	1.3	2.4	–	–	–	–
Public administration and defense	5.9	5.3	–	–	–	–
Social, community, and private services	6.7	9.4	16.1	20.2	15.6	30.5
Financial services	2.5	5.6	–	–	–	–
Total	100.0	100.0	100.0	100.0	6.5	11.6

Source: Authors' calculations using 2007/2008 SAM for Pakistan

services (27 % and 53 %, respectively). Livestock accounts for more than half of the value added in the agricultural sector. Much of the industrial production is strongly linked to agriculture, including wheat, rice and sugar milling, and textile production (linked to cotton).[5] Trade (wholesale and retail) and transport generate more than half of the value added in services. Exports are a relatively low share of total output (6.5 %); imports are concentrated in the industrial sector (including petroleum products, part of the mining sector) and in private services (particularly business services).

Table 8 shows the composition of value added across sectors. For agricultural products, land is the largest component of value added. Manufacturing activities depend heavily on formal capital, while labor and other capital are important for most services.

Large and medium farmers in Pakistan earn a large share of their income from land (Table 9). However, small and landless farmers rely on labor, livestock, and other capital for most of their income. Rural nonfarm and urban households rely mostly on their labor and other capital as sources of income.

The importance of agricultural income by household group is generally lower in the recent SAM than in the PRHS of 2001/2002, suggesting that households have more diversified income sources than are revealed by PRHS data (Table 10). This is consistent with the tendency toward diversification of rural incomes found using different spans of HIES: income from crop production as a share of total income in rural Pakistan was 22.9 % in HIES 2001/2002 and 21.5 % in HIES 2007/2008. In addition, PRHS 2000/2001 had a relatively detailed module on agricultural production, which may have allowed it to capture the existing agricultural income to a larger extent. The SAM also shows that agricultural income accounts for a large share of the income of farmers—especially for medium and large farms—which is consistent with PRHS data.

5 Income Multiplier Analysis

To illustrate the use of the SAM, we use income multiplier analysis. To capture the production and consumption linkages, taking into account the supply rigidities present in Pakistan, we use a semi-input–output model with constrained linear relationships among quantities in the model and fixed prices. In this approach, sectors are classified into two groups: those that are supply constrained and those that are supply responsive. Output responses are permitted only in supply-responsive sectors. For this model to produce a suitable approximation of reality, the supply-constrained sectors must correspond to tradable goods. Therefore, in the approach we follow, the imbalances between supply and demand in these sectors are solved via changes in net exports.

The starting point is the sector-specific equilibrium conditions, that is, $x_c(1 + tc_c) = \sum_{c'} z_{cc'} + \sum_h c_{ch} + g_c + i_c + e_c$, where x_c is precommodity-tax gross output, tc_c is commodity tax rate, $z_{cc'}$ is intermediate demand of good c by sector c', c_{ch} is household consumption of good c by household h, g_c is public consumption of

[5] Not tabulated.

Table 8 Composition of value added

	Land (%)	Labor (%)	Livestock (%)	Formal capital (%)	Other capital (%)	Total (%)	GDP (%)
Agricultural sector	28.6	15.9	37.8	11.4	6.3	100.0	20.1
Crops	63.5	27.0	0.0	0.0	9.5	100.0	8.9
Livestock	0.0	6.7	72.6	20.7	0.0	100.0	10.6
Fishing	0.0	18.3	0.0	23.4	58.4	100.0	0.5
Forestry	50.0	5.7	0.0	0.0	44.3	100.0	0.3
Industrial sector	0.0	25.9	0.0	60.7	13.5	100.0	26.9
Mining and quarrying	0.0	72.0	0.0	28.0	0.0	100.0	3.0
Manufacturing	0.0	16.9	0.0	68.4	14.7	100.0	19.7
Electricity, gas, and water distribution	0.0	15.6	0.0	84.4	0.0	100.0	1.5
Construction	0.0	45.4	0.0	27.3	27.3	100.0	2.6
Services sector	0.0	26.7	0.0	24.6	48.6	100.0	53.0
Wholesale and retail	0.0	8.9	0.0	27.3	63.8	100.0	18.5
Transport and communication	0.0	24.2	0.0	22.7	53.1	100.0	11.7
Ownership of dwellings	0.0	8.9	0.0	30.2	60.9	100.0	2.4
Public administration and defense	0.0	64.2	0.0	35.8	0.0	100.0	5.4
Social, community, and private services	0.0	49.9	0.0	15.0	35.1	100.0	9.4
Financial services	0.0	23.7	0.0	22.9	53.4	100.0	5.6

Source: Authors' calculations using 2007/2008 SAM for Pakistan

Table 9 Household income shares

	Land (%)	Labor (%)	Livestock (%)	Formal capital (%)	Other capital (%)	Government (%)	Nonresidents (%)	Total (%)	National income (%)
Large and medium farm—Sindh	57.7	11.0	7.4	0.0	16.0	4.8	3.2	100.0	1.5
Large and medium farm—Punjab	31.8	9.2	14.0	0.0	37.3	4.2	3.5	100.0	6.2
Large and medium farm—other	42.5	19.7	4.2	0.0	27.9	2.8	3.0	100.0	0.8
Small farm—Sindh	15.1	12.2	18.4	0.0	37.6	8.5	8.3	100.0	1.8
Small farm—Punjab	11.4	9.6	24.1	0.0	39.0	7.8	8.1	100.0	11.5
Small farm—other	9.3	16.9	11.1	0.0	47.9	7.0	7.9	100.0	3.3
Landless farmer—Sindh	11.5	10.0	21.1	0.0	41.8	7.0	8.5	100.0	1.4
Landless farmer—Punjab	8.2	13.9	37.1	0.0	25.5	7.3	8.0	100.0	1.8
Landless farmer—other	5.7	16.5	18.1	0.0	43.8	7.1	8.6	100.0	0.8
Landless agricultural laborers—Sindh	0.0	21.7	3.5	0.0	59.7	6.6	8.6	100.0	1.5
Landless agricultural laborers—Punjab	0.0	21.0	11.9	0.0	53.4	6.1	7.7	100.0	1.4
Landless agricultural laborers—other	0.0	33.7	1.8	0.0	49.8	6.3	8.4	100.0	0.2
Rural nonfarm quintile 1	0.0	36.1	6.7	0.0	46.3	4.9	6.0	100.0	2.8
Rural nonfarm quintile 2	0.0	38.9	8.5	0.0	39.3	6.1	7.3	100.0	3.3
Rural nonfarm other	0.0	36.3	5.4	0.0	42.7	7.3	8.3	100.0	17.3
Urban quintile 1	0.0	59.8	0.0	0.0	25.3	6.9	8.0	100.0	2.6
Urban quintile 2	0.0	63.2	0.0	0.0	21.2	7.2	8.4	100.0	3.4
Urban other	0.0	16.8	0.0	59.7	12.2	4.4	6.9	100.0	38.5
Rural farm subtotal	16.9	12.3	18.1	0.0	39.2	6.6	6.9	100.0	32.1
Rural nonfarm subtotal	0.0	36.7	6.0	0.0	42.7	6.8	7.9	100.0	23.4
Urban subtotal	0.0	22.9	0.0	51.7	13.6	4.8	7.1	100.0	44.5
Total households	5.4	22.7	7.2	23.0	28.6	5.8	7.2	100.0	100.0

Source: Authors' calculations using 2007/2008 SAM for Pakistan

Table 10 Rural agricultural incomes

Household group	Share of agricultural income in PRHS (%)	Share of agricultural income in SAM (%)
Medium and large farms	83.5	66.0
Small farms	67.9	41.2
Landless farmers	87.7	45.6
Rural agricultural workers	53.1	22.2
Rural nonfarm nonpoor	1.9	6.7
Rural nonfarm poor	6.3	9.7
Rural agricultural	74.8	46.5
Rural	69.7	30.1

Source: Authors' calculations using PRHS 2001/2002 and 2007/2008 SAM for Pakistan

good c, i_c is investment (fixed and change in stock) demand for good c, and e_c is net export of good c. Intermediate and factor demand are assumed to be proportional to output production, that is, $z_{cc'} = a_{cc'}x_{c'}$ and $v_{fc'} = a_{fc'}x_{c'}$, where $a_{cc'}$ and $a_{fc'}$ are the requirements of intermediate input c' and factor f to produce a unit of c. Household consumption is given by $c_{ch} = \theta_{ch}(1 - th_h)y_h$, where y_h is pretax income of household h, th_h is the corresponding tax rate, and θ_{ch} is the share of post-tax income of household h spent on commodity c. Finally, pretax household income is the sum of factor income and transfers received by the household from other agents, that is, $y_h = \sum_f a_{hf}v_f + tr_h$, with $v_f = \sum_c v_{fc}$, and a_{hf} being the share of household h in the income of factor f.

Replacing the intermediate and factor demand and household demand function in the equilibrium condition, we find that $x_c(1 + tc_c) = \sum_{c'}(a_{cc'}x_{c'}) + \sum_h\{\theta_{ch}(1 - th_h)[\sum_f(a_{hf}(\sum_{c'} a_{fc'}x_{c'})) + tr_h]\} + g_c + i_c + e_c$, which can be solved either for x_c (demand-constrained sector) or for e_c (supply-constrained sector), fixing either e_c (demand-constrained sector) or x_c (supply-constrained sector).

We conduct a series of simulations in which a constant injection is applied to the economy (100 billion rupees during the year), either to supply (supply-constrained sector) or to net export demand (remaining sectors). We run a simulation focusing the injection only on crops, where each crop receives the proportion of the total injection based on its share in the total value added of crops. We then do the same for livestock, industry, services, and all sectors, totaling five simulations. Finally, we divide the absolute changes in output values by the injection, obtaining the output multipliers shown in Table 11. All aggregate output multipliers are in the 1.1–1.4 range, with livestock and industry having the highest output multipliers. These multipliers are significantly below the multipliers found for India by Pal et al. (2012), probably reflecting the fact that their analysis assumes the absence of supply rigidities, which we seek to capture here. Our estimates are aligned with the 1.5 value-added multiplier reported in Dorosh et al. (2003), Haggblade et al. (1991), and Mellor (1995). As expected, the output multipliers are largest in the sectors where the injection takes place (main diagonal of the table). We also find that the direct effects are larger than

Table 11 Output multipliers for sector-specific simulations (rupees of sector output change per rupee of injection)

	Crops simulation	Livestock simulation	Industry simulation	Services simulation	All sectors simulation
Crops	1.007	0.054	0.053	0.000	0.110
Livestock	0.004	0.991	0.003	0.005	0.109
Industry	0.139	0.020	1.049	0.024	0.308
Services	0.077	0.259	0.226	1.135	0.696
Total	1.227	1.324	1.337	1.165	1.233

Source: Authors' semi-input–output analysis based on Pakistan SAM 2007/2008

the indirect effects, that most of the indirect effects are concentrated in the service sector (a significant supplier to the other sectors, especially in the case of trade and transport),[6] and that the injection in the service sector has the lowest output multiplier for the entire economy.

These injections significantly change the distribution of income among households in light of the economic structure of Pakistan, as the income multipliers in Table 12 show. A direct injection in the crops sector especially benefits small and medium/large farms in Punjab, where a large share of crop production is concentrated (particularly wheat, cotton, and horticulture). Higher production of livestock especially benefits the small farms in Punjab—which receive around 38 percent of total livestock income—and, to a lesser extent, the top three quintiles of the urban sector, which own most of the formal capital used in the livestock sector. An injection in the industrial sector leads to significantly higher imports of petroleum and manufactured goods, leading to a reduced total household income multiplier (only 0.44) and to benefits especially for the top three quintiles of the urban sector, which own most of the capital stock. Given that services use skilled labor in a relatively intensive way (compared to other sectors) and that most of the skilled labor is found in the top three quintiles of the rural nonfarm and urban socioeconomic groups, an injection in the service sector benefits these groups in particular. Finally, given the large share of the service sector in the Pakistani economy (53 % of its value added), a generalized injection also ends up benefiting in particular these two socioeconomic groups, though the small farms of Punjab benefit to some extent as well.

6 Conclusions

This paper has provided future researchers of economic structure with a model for building a SAM, that is, a unique countrywide database for use in structural analysis. It has also applied this model to the empirical investigation of the economic structure of Pakistan. Thus, this work is an attempt to provide a useful reference and resource for academics concerned with economic structure, particularly that of Pakistan.

[6] The only exception is the injection in crops, with the largest indirect effect seen in industry.

Table 12 Household income multipliers for sector-specific simulations (rupees of household income change per thousand rupees of injection)

	Crops simulation	Livestock simulation	Industry simulation	Services simulation	All sectors simulation
Large and medium farm—Sindh	92	15	7	2	13
Large and medium farm—Punjab	220	87	19	31	51
Large and medium farm—other	42	4	3	3	7
Small farm—Sindh	36	26	4	8	11
Small farm—Punjab	155	215	21	49	69
Small farm—other	41	35	8	23	22
Landless farmer—Sindh	21	21	3	6	8
Landless farmer—Punjab	22	49	3	7	12
Landless farmer—other	7	10	1	4	4
Landless agricultural laborers—Sindh	7	14	2	8	7
Landless agricultural laborers—Punjab	5	21	3	12	10
Landless agricultural laborers—other	1	2	0	1	1
Rural nonfarm quintile 1	3	20	9	29	21
Rural nonfarm quintile 2	3	27	11	31	23
Rural nonfarm other	13	94	55	137	99
Urban quintile 1	2	4	9	23	16
Urban quintile 2	2	4	12	25	17
Urban other	37	158	268	301	252
Total households	710	807	440	702	643

Source: Authors' semi-input–output analysis based on Pakistan SAM 2007/2008

Using a variety of information sources, we have built an updated SAM for Pakistan that is perfectly consistent with the macroeconomic figures for the country and that is highly disaggregated, allowing for detailed distributional analysis of the economic structure of the country.[7] The presented approach to building SAMs is motivated by an information theoretic approach to estimation (Judge and Mittelhammer 2012) that takes a Bayesian view of the efficient use of information: "Use all the information you have, but do not assume any information you do not have."

This SAM provides rich and updated detail on the income and expenditure patterns of the production sectors, production factors, and households of the Pakistani economy, reflecting in a significant way the heterogeneity of the income and expenditure compositions of domestic households and, as a result, allowing the distributional effects of changes in the composition of economic output to be traced. The SAM highlights a series of relevant characteristics of the Pakistani economy. The livestock (10.5 % of the economy) and trade (18.4 % of the economy) sectors are shown to be significant contributors to the total domestic value added. For agricultural products, land is, unsurprisingly, the largest component of value added. Manufacturing activities depend heavily on formal capital, while labor and other capital are important for most services. Large and medium farmers in Pakistan earn a large share of their income from land. However, small and landless farmers rely on labor, livestock, and other capital for most of their income. Rural nonfarm and urban households rely mostly on their labor and other capital as income sources.

The income multiplier analysis we subsequently conduct captures the production and consumption linkages in the economy. Taking into account the supply rigidities present in Pakistan, we use the semi-input–output model. Results suggest that the direct effects are larger than the indirect effects and that most of the indirect effects are concentrated in the services sector.[8] The injection in the services sector has the lowest output multiplier for the entire economy. Finally, our analysis suggests that the injections lead to income changes that differ across socioeconomic groups, a direct result of the heterogeneity in the income generation of these groups that the countrywide database we estimated captures.

Competing interests

The authors declare that they have no competing interests.

Appendix: Sectors in the Input–Output Matrix

1 Crops: Rice (paddy)
2 Crops: Wheat
3 Crops: Cotton (seed cotton)
4 Crops: Sugarcane

[7] The resulting SAM is available at www.ifpri.org.

[8] The only exception is the injection in crops, with the largest indirect effect seen in industry.

5 Crops: Tobacco
6 Crops: Other crops
7 Crops: Pulses and grams
8 Crops: Potatoes
9 Crops: Fruits
10 Crops: Vegetables and other condiments
11 Crops: Oil seeds
12 Crops: Other
13 Livestock
14 Forestry
15 Fisheries
16 Mining: Coal
17 Mining: Crude oil and natural gas
18 Mining: Other minerals
19 MF: Vegetable oils, etc.
20 MF: Milling
21 MF: Bakery products
22 MF: Sugar
23 MF: Other food products
24 MF: Beverages
25 MF: Cigarettes, tobacco
26 MF: Ginned cotton (lint)
27 MF: Cotton yarn
28 MF: Cotton cloth
29 MF: Art silk
30 MF: Made-up textile goods
31 MF: Knitwear
32 MF: Carpets
33 MF: Garments
34 MF: Other textile products
35 MF: Leather, leather products
36 MF: Footwear
37 MF: Wood, wooden products, furniture
38 MF: Paper, paper products
39 MF: Pharmaceutics
40 MF: Fertilizers and pesticides
41 MF: Chemicals: Consumer products
42 MF: Refined petroleum
43 MF: Rubber and plastic products
44 MF: Other chemicals
45 MF: Bricks, tiles
46 MF: Cement
47 MF: Other nonmetallic mineral products
48 MF: Basic metal products
49 MF: Other metal products
50 MF: Other nonelectrical machinery

51 MF: Electrical equipment, etc.
52 MF: Other transport equipment
53 MF: Surgical instruments
54 MF: Handicrafts
55 MF: Sports goods
56 MF: Jewelry (precious metal)
57 MF: Other manufacturing products
58 Electricity and water works
59 Gas supply
60 Construction: Buildings and land improvement
61 Trade: Wholesale
62 Trade: Retail
63 Hotel and restaurant services
64 Transport: Railway
65 Transport: Road
66 Transport: Water
67 Transport: Air
68 Transport: Other and storage
69 Communication services
70 Banking: Central monetary authority
71 Banking: Other monetary institutions
72 Banking: Other credit institutions
73 Banking: Nominal product
74 Insurance
75 Real estate services
76 Imputed rent (owner-occupied dwellings)
77 Business services
78 Public administration and defense
79 Education
80 Healthcare
81 Other social and cultural services
82 Personal and household services

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